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DEFENSE INTELLIGENCE AGENCY
WASHINGTON, D.C. 20301

13 JAN 1970

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(Book)
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mc&g

MEMORANDUM FOR EXECUTIVE SECRETARY, COMIREX

SUBJECT: Request for DOPPLER Information

In response to your request, attachment is a simplified explanation of how the Doppler system works to provide positioning data for MC&G purposes.

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1 Enclosure a/s

Chairman
COMIREX MC&G Working Group

DIA and NRO review(s)
completed.

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DOPPLER SATELLITES

1. ☐ The DOPPLER satellite navigation or positioning system is based on a transmitter in the satellite which sends a continuous unmodulated wave on a fixed known frequency. The signal received on the ground exhibits a change in frequency when compared to a standard of the satellite frequency, which is due to the relative velocity of the satellite with respect to the receiver. This shift of frequency is called the DOPPLER effect and is named for Johann Doppler of Prague, Czechoslovakia, who first observed the phenomena in 1842. The shift of the radio frequency of the satellite - with relation to a receiver is analogous to the change in pitch of the whistle of a high speed train as it approaches and passes a listener. The frequency received by the ground receiver is a function of the transmitted frequency from the satellite, the velocity of the radio signal in the atmosphere and the rate of change of the distance between the satellite and the tracking station. From this information a simple equation is formed in which 3 of the 4 quantities are known, i.e., transmitted frequency, the received frequency and the velocity of propagation. The remaining unknown to be solved for is the radial velocity of the satellite and from this the distance between the observer and the satellite at a specific time can be determined. With the distance to the satellite at several points and a knowledge of the satellite orbit the observers position can be determined. A DOPPLER satellite orbit can be determined very precisely using a number of tracking stations located on known points and the highly accurate earth gravity models. DOPPLER is a passive system in the sense that the transmissions are only from the satellites to the ground station.

2. ☐ The Doppler beacon on the KH-4 system will be tracked by a worldwide network of 21 stations. By analyzing the Doppler data as discussed above we will be able to determine the satellite orbit and thus its position very accurately when photographs are taken of areas of interest. By knowing the position of the satellite when the photograph is taken we are able to compute, through photogrammetric techniques, the position of any feature identified and measured on the photograph.

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